RATES, RATIOS AND PER CAPITA VARIABLES IN INTERNATIONAL MODELS: ANALYSIS OF INVESTMENT AND FOREIGN TRADE IN OECD COUNTRIES

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Abstract

Some econometric models try to explain the rate of growth of real Gross Domestic Product per capita as a function or ratios like Investment/GDP or Exports/GDP, often with confusing results and conclusions which are misleading when the studies do not show a positive impact of the explanatory variables. Some of these approaches are inspired in the Solow´s model, which is indeed interesting at a theoretical level when the hypotheses of the model hold in one country for a short period of time. It happens that some hypotheses of the model do not hold for long samples of a same country or in international comparisons. Usually economic growth of real GDP per capital increases with Investment per capita but the Investment/GDP ratio often diminish with the increase of Investment per capita. In the case of these two explanatory variables it is much more convenient and realistic to use real per capita values, instead of ratios, for the explanation of economic development. Besides we include other considerations of interest regarding international differences of Exports per capita among countries. We present data, graphs and estimations of interest in this regard for 25 OECD countries.

Keywords: Growth Models, Rates and Ratios, Per capita real GDP, Economic Development, Comparisons of OECD countries.

JEL Codes: O51, O52, O54, O57

1. Introduction

The main aim of this article is to point to the convenience of using per capita variables, better than rates and ratios, when we try to see the effects of investment and foreign trade on economic development. Firstly in section 2 we present a summary reference to the literature in relation with the use of rates and ratios in cross-country econometric models of development and some problems which are present in many applications based on those approaches.

In section 3 we analyze the effect of investment and show that while investment per capita is a good proxy for the increase of the stock of capital per capita, the Investment/GDP ratio usually is not a good explanatory variable in many applications, so in international cross-sections or pools as in times series analysis of one country. Section 4 analyses the convenience to express foreign trade in per capita terms, better than using a proxy given by the ratio Exports/GDP or other ratios, in order to explain the effects on real GDP per capita. Finally in section 5 we present in section 3 and the effect of foreign trade in section 4. Finally we present the main conclusions in section 5. The Annex includes some supplementary comments and data.

2. Summary of literature

In this study we refer to *growth models* as those focused to explain the increase of real Gross Domestic Product, while we prefer to use the term *economic development models* to those which explain the increase in real income per capita and economic well-being, although in the economic literature it is rather frequent the use both terms with the same meaning in reference to real GDP per capita.

In the Solow-version of the neoclassical model, under several assumptions related with constant returns to scale and the stability of the Investment/GDP ratio and other parameters, the steady state income level per worker of a country (Y*/L) is determined by the fraction of output that is saved and invested (s =I/Y)), the labor force growth rate (n), the rate of depreciation of the stock of capital (δ), the rate of growth of technological progress (g) and time (t):

$$\text{Ln}\,(Y^*/L) = \ln(A_0) + g\,t + (\alpha/(1-\alpha))\ln(s) - (\alpha/(1-\alpha))\ln(n+g+d) + u \quad (1)$$

Several authors, as those cited in Guisan and Neira(2006), such as Denison(1967) and Guisan(1980) among others, where pioneers in the inclusion of the stock of human capital in quantitative and econometric models based on international comparisons. In the 1990s several authors proposed augmented versions of the Solow´s model given by (1).

Mankiw, Romer and Weil(1992) examines whether the Solow model is consistent with the international variation in real income per capita, and propose an augmented Solow model that includes accumulation of human capital besides physical capital in the model by adding a new term in equation (1), instead of the term "g t", related with human capital, and they estimate the following model:

$$\text{Ln } (Y^*/L) = \beta_0 + \beta_1 \ln(s) + \beta_2 \ln(n+g+d) + \beta_3 \ln(S_t) + u \qquad (2)$$

Where S_t is a proxy of human capital and u the random shock.

Other augmented versions of the Solow´s model includes other ratios, such as Exports/GDP ratio, and other explanatory variables trying to improve the explanation of economic development.

Following these approaches many econometric models based on international samples have related the evolution of real Gross Domestic Product per capita with the Investment/GDP ratio, and several discussions and criticism have arisen about the stability of some of the parameters of the model, both through time and across countries.

Levine and Renelt((1992) show concern about the fragile results of cross-country regressions based on several extensions of the Solow´s approach. The aim of their article is to assess the robutstness of several (over 50) variables that have been found to significantly affect economic development by the vast literature on cross-country studies. They analyze those models within a general augmented model of the type:

$$Y = \beta_1 I + \beta_2 M + \beta_3 Z + u \qquad (3)$$

Where Y is the rate of growth of real GDP per capita, I is a set of variables usually included in augmented models (like the investment share of GDP, a proxy for education and the initial value of GDP per capita), M is the variable of interest in each particular study, and Z is a set of other variables identified in pass studies as potentially important in the explanation (ratio Exports/GDP, share of

Government Expenditure on GDP, inflation rate and domestic credit growth rate among others).

McQuinn and Whelan(2007) analyze the criticisms to the Solow´s model and find that after 50 years the balance is positive and they state: "*Thus to the extent that the model makes predictions about cross-country growth dynamics, the evidence suggests it actually fits well*". They found that some attempts in the 1980s and 1990s addressed to explain technological efficiency across country have been not very successful and they consider that other approaches of the late 1990s and early 2000s, related with institutions are more promising and add: "*recent research has begun to focus more on detailed examinations of the effects on long-run growth of less mechanical factors such as institutions, which Solow has always viewed as likely to be important determinants of cross-country growth patterns*".

Sianesi and Van Reenen(2000) state that "new growth theories" emphasise the endogenous determination of growth rates, which are explained within the model instead of being driven by exogenous technological progress. They points to the question related with education and state: "*While education has no role in traditional neo-classical theories of economic growth, the new approaches have explicitly brought the role of education to the fore. They provide the theoretical underpinnings for assuming that education can affect national economic growth via two main channels*". One channel refers to explicitly incorporate human capital as a factor in the production function and the other channel refers to the role of human capital in the explanation of new knowledge/technology.

Accordingly to Neira and Guisan((2002), Neira(2003), and Guisan and Neira(2006) the neoclassical production function includes important indirect effects of education on economic development, because one of the main sources of increase of real income per capita (per worker or per inhabitant) is the increase of the stock of capital per capita, and that is very much related with human capital. Societies with high educational level have several features

that usually contribute to increase K/L and K/Population: Firstly education contributes to moderate excessively high fertility rates, as demonstrated in Guisan, Aguayo and Exposito(2001) and thus to increase savings and investment per capita. Secondly highly educated societies are more prepared to deal with efficient methods of production with a high ratio of stock of capital per worker. Thirdly there are other positive effects of education on social capital and other factors which contribute to increase labour productivity and income per inhabitant.

We agree with many aspects of the neoclassical approach and Solow´s model, as a part of the explanation of economic development differentials among countries, although other important supplementary relationships must be also considered, both from the supply side and the demand side, as analysed in Guisan(1980), Klein(1989) and other studies.

Nevertheless we find some controversial questions which scarcely has been remarked in the econometric literature, regarding the assumptions of constant returns to scale and the stability of the Investment/GDP ratio, or other ratios. In our view the analysis of data, both in international comparisons and in times series analysis of one country, show that these assumptions do not hold in many empirical applications.

Here we will show that it is much more interesting to relate per capita GDP, or changes in this variables, with changes in per capita Stock of capital (or changes in this variables), instead of using a mix of rates and ratios which do not hold in may samples. A few interesting articles have been previously published in this regard as that by Rao, Singh and Gounder(2007).

We also agree that many augmented cross-section models of economic development present interesting contributions when they are not applied mechanically but with ability to find some relevant explanatory variables. Education and social capital, including the quality of institutions, are indeed highly related with economic development but usually as complementary and not as substitutes of

the stock of capital per capita. Really there are many complementary relationships, some times unilateral, some times bilateral with lags and in a few cases bilateral without lags, among several of those factors.

Several authors, as Fielding(1998) and Tabellini(2008) point to the importance of including social capital as a key variable in the explanation of international differences of socio-economic development.

Interesting surveys and analyses of different approaches to economic development have been presented in Klein(1989), Arrous(1999), Van den Berg(2000), Temple(2001), Barro and Sala-i-Martin(2003), Valadkhani(2005), Guisan(2009), and other studies.

Guisan(2009) includes an interesting figure showing how human capital, social capital, physical capital, foreign trade, natural resources and other variables interact to explain the evolution of real income per capita and socio-economic development. One remarkable point of interest of this figure is that it has into account the important inter-sector relationships between industrial and non industrial sectors among other features, and the positive role of foreign trade not only from the demand side (increasing Exports) but also from the supply side (increasing Imports of intermediate inputs or capital goods of interest to foster economic development.

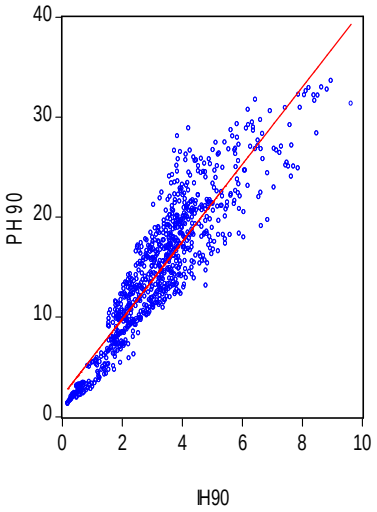
3. Capital and Investment per capita versus Investment Ratio

We show that GDP per capita (PH) is more related with the stock of capital per capita (KH), or even with a proxy given by Investment per capita (IH), than with the Investment/GDP ratio (IR). It is due to the fact that KH is usually a very important explanatory variable for PH and KH is more positively related with IH than with IR. The following graphs show the relationships of PH with IH, IR and KH in OCDE countries, during the periods 1961-1995 and 1960-2005.

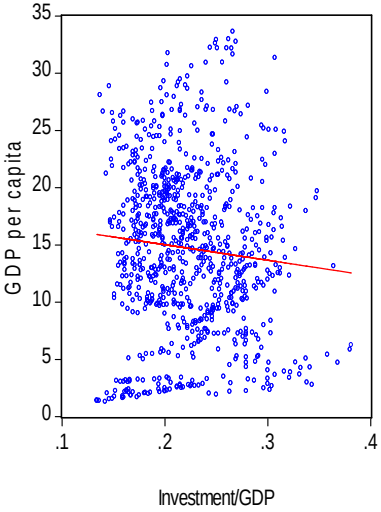
3.1. Sample of 25 OECD countries 1961-1995

Graph 1 shows a clear positive relationship between PH and IH with a sample of 25 OECD countries for the period 1960-95, while graph 2 show little correlation, slightly negative, between PH and the ratio Investment/GDP. In this case IH is Gross Fixed Capital Formation per capita from OECD National Accounts.

Graph 1. PH and IH, OECD25



Graph 2. PH and IR, OCDE25



The reason for a more positive relationship between PH and IH is explained by the important role of KH, among other factors in the explanation of economic development. Although IH not always is a good proxy for KH, it is usually a better one that the Investment/GDP ratio, because KH and IH are very often positively related while the Investment/GDP ratio is very often negatively related with KH and PH.

Table 1 shows the evolution of PH, IH, and the ratio I/GDP in 25 OECD countries for the years 1961 to 1995. The per capita variables, indicated with H in the last letter of the name, are in thousand dollars per inhabitant at 1990 prices and exchange rates:

PH = real GDP per capita
IH = Gross Fixed Capital Formation per capita
IR= Investment Ratio = I/GDP =IH/PH
X/GDP=Ratio XH/PH

Table 1. Gdp pc, Investment pc and ratio I/GDP, 1961-1995

Country	PH 1961	PH 1995	IH 1961	IH 1995		I/GDP 1961	I/GDP 1995
Australia	8.645	18.905	2.135	3.993		0.247	0.211
Austria	8.345	22.125	2.001	5.617		0.240	0.257
Belgium	8.289	20.636	1.721	3.705		0.208	0.180
Canada	9.873	20.824	1.531	4.162		0.155	0.200
Denmark	13.090	28.866	2.626	4.210		0.201	0.146
Finland	10.670	25.677	3.360	4.115		0.315	0.160
France	9.344	21.792	1.856	4.097		0.199	0.190
Germany	9.345	21.686	2.547	4.920		0.273	0.227
Greece	2.834	8.437	0.797	1.993		0.281	0.236
Iceland	9.162	24.195	1.844	3.670		0.201	0.152
Ireland	4.959	17.017	0.734	2.927		0.148	0.172
Italy	7.574	20.187	2.168	3.584		0.286	0.176
Japan	5.715	25.428	1.234	7.485		0.216	0.294
Luxembourg	12.019	32.902	3.281	8.220		0.273	0.250
Mexico	1.754	3.132	0.285	0.478		0.162	0.153
Netherlands	9.015	20.362	2.297	4.072		0.255	0.200
New Zealand	9.061	13.679	1.656	2.804		0.183	0.205
Norway	11.184	31.741	3.071	6.437		0.275	0.203
Portugal	2.082	7.659	0.613	2.123		0.295	0.279
Spain	4.599	13.365	0.812	2.950		0.177	0.221
Sweden	13.855	26.647	2.895	4.257		0.209	0.160
Switzerland	20.368	32.149	4.456	8.517		0.219	0.265
Turkey	1.254	2.863	0.177	0.679		0.141	0.237
UK	9.082	17.961	1.541	3.008		0.170	0.169
USA	12.456	23.125	2.086	4.142		0.168	0.169

Note: GDP per capita (PH) and Investment per capita (IH) in thousand dollars at 2000 prices and exchange rates. Ratio I/GDP=IH/PH. Source: Elaboration from OECD National Accounts Statistics.

We notice that the I/GDP ratio has diminished in 16 countries and shows increase only in 9 countries. In spite of that IH and PH show important increases for the period 1961-1995 in the 25 OECD countries of table 1, because in advanced states of economic development countries may afford important increases in KH and PH by applying relatively small shares of real GDP to Investment.

Table 2 shows the correlations between GDP and Investment in 25 OECD countries, including per capita relationships, rate to rate, rate to share (ratio Investment/GDP) and per capita to share.

Table 2. 25 OECD countries 1962-1995:
Correlations between GDP and Investment

PC/PC	Rate/Rate	Rate/share	PC/share
0.9112	0.6946	0.2767	-0.0869

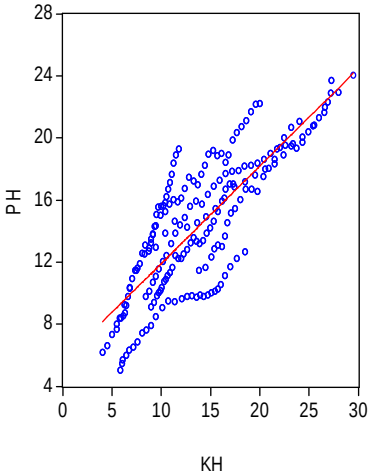
Note: pc means per capita, rate is the exponential rate of growth, share is the Investment/Output Ratio

As expected, accordingly to the graphs, we find that the highest positive correlation correspond to the per capita real GDP with the per capita real Investment, and thus de pc/pc relationship seems to be the most interesting option for explaining the level of real GDP per capita while the pc/share seems to be the worst of those options.

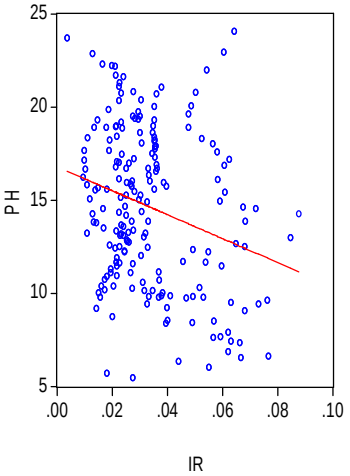
3.2. Sample of 7 OECD countries, 1962-1990 and 1960-2005

Graph 3 shows that relationship between real Gdp per inhabitant (PH) and real stock of capital per inhabitant (KH) in a sample of the 7 most populated OCDE countries of the period 1962-90: France, Germany, Italy, Japan, Spain, the United Kingdom and the United States, and graph 4 shows the relationship between PH and IR, being IR in this case the increase of KH (IR=KH-KH(-1)), where KH(-1) is the lagged value of KH. The estimations of KH where elaborated Denison and OECD. Graph 5 presents the relationship between the natural logarithms of GDP per worker (PM=GDP/L)) and capital per worker (KM=K/L), Data in those graphs are expressed in dollars per worker at 1990 prices and exchange rates. Graph 6 relates log(PM) with the log of the Investment/GDP ratio, being PM and KM expressed in dollars per worker at 2000 prices and exchange rates, for the period 1960-2005.

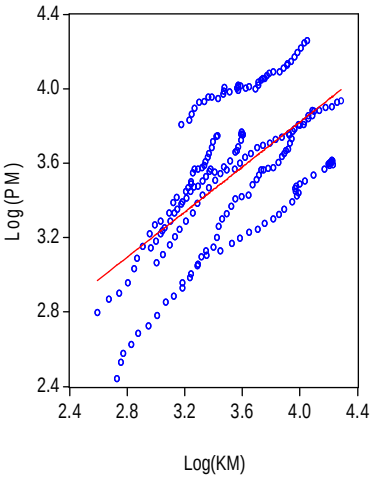
Graph 3. PH and KH, OECD7



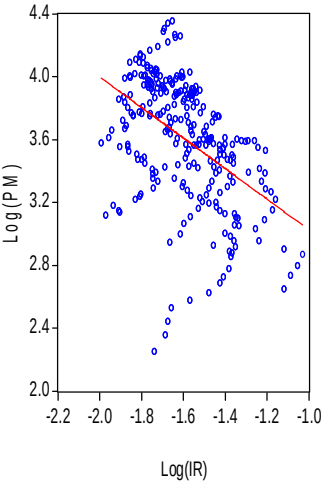
Graph 4. PH and IR, OECD7



Graph 5. logs of PM and KM



Graph 6. Logs of PM and IR



Note: Natural logarithms of GDP per worker and Stock of Capital per worker. Log(IR) is the natural logarithm of the Investment/GDP ratio.

We may notice that, among other production factors, the stock of capital per capita (KH or KM) is a very important variable to explain differences of real GDP per capita (PH or PM) among countries, as well as the evolution of a country through time.

Table 3 shows the correlations of PH with KH and IR in the seven OECD countries for the period 1963-90.

Table 3. Correlation of GDP per capita (PH)
With KH and IR in 7 OECD countries, 1963-1990

Country	KH	IR
France	0.9679	0.6125
Germany	0.9866	-0.5634
Italy	0.9941	-0.7093
Japan	0.9802	-0.2211
Spain	0.9676	0.0241
UK	0.9852	0.1947
USA	0.9847	-0.0629
OECD7	0.8061	-0.2586

Note: PH and KH are GDP and real Stock of capital, per inhabitant. IR is the Investment/GDP Ratio. Source: Elaboration from Denison and OECD

As well as in the sample of 25 OECD countries we found that it is better to use per capita variables than the Investment/GDP ratio. As commented in section 2 the international experience shows that many other variables relevant for economic development have causal direct or indirect effects on the stock of capital per capita

4. Exports and GDP per capita versus Exports/GDP ratio

Table 4 shows the evolution of real GDP per capita (PH), Exports per capita (XH), Imports per capita (MH) and the Exports/GDP Ratio (XR), for the period 1961-95 in 25 OECD countries. Data of PH, XH and MH are expressed in thousand dollars per inhabitant at 1990 prices and exchange rates. Data in purchasing power parities (PPPs) are shown in the Annex.

Table 4. GDP per capita and Foreign Trade, 1961-1995

Country	PH	PH	XH	XH	XR	XR	MH	MH
	1961	1995	1961	1995	1961	1995	1961	1995
Australia	8.645	18.905	0.999	4.014	0.116	0.212	1.010	4.028
Austria	8.345	22.125	1.228	9.517	0.147	0.430	1.333	9.606
Belgium	8.289	20.636	2.732	16.052	0.330	0.778	2.809	15.219
Canada	9.873	20.824	1.321	7.634	0.134	0.367	1.120	6.959
Denmark	13.090	28.866	2.398	11.039	0.183	0.382	2.771	10.121
Finland	10.670	25.677	1.679	8.939	0.157	0.348	1.706	7.032
France	9.344	21.792	0.888	5.659	0.095	0.260	0.795	5.260
Germany	9.345	21.686	1.258	5.921	0.135	0.273	1.009	5.993
Greece	2.834	8.437	0.144	1.581	0.051	0.187	0.292	2.543
Iceland	9.162	24.195	3.017	8.539	0.329	0.353	2.346	7.378
Ireland	4.959	17.017	0.976	13.271	0.197	0.780	1.238	10.019
Italy	7.574	20.187	0.627	5.548	0.083	0.275	0.644	4.526
Japan	5.715	25.428	0.198	3.117	0.035	0.123	0.339	2.814
Luxembourg	12.019	32.902	7.886	30.902	0.656	0.939	8.170	28.024
Mexico	1.754	3.132	0.145	0.988	0.083	0.315	0.239	0.827
Netherlands	9.015	20.362	2.376	12.363	0.264	0.607	2.389	10.847
New Zealand	9.061	13.679	1.520	4.385	0.168	0.321	1.570	4.335
Norway	11.184	31.741	2.622	14.056	0.234	0.443	3.250	10.544
Portugal	2.082	7.659	0.330	2.933	0.159	0.383	0.507	3.904
Spain	4.599	13.365	0.286	3.454	0.062	0.258	0.216	3.502
Sweden	13.855	26.647	2.137	10.783	0.154	0.405	2.520	8.994
Switzerland	20.368	32.149	3.893	12.381	0.191	0.385	3.329	12.330
Turkey	1.254	2.863	0.060	0.501	0.048	0.175	0.088	0.620
UK	9.082	17.961	1.321	5.124	0.145	0.285	1.358	5.188
USA	12.456	23.125	0.572	2.972	0.046	0.129	0.632	3.388

Note: PH, XH and MH are, respectively, Gdp per capita, Exports pc and Imports pc, all in thousand dollars per inhabitant at 1990 prices and exchange rates. XR is the Exports Ratio: XR=XH/PH. Source: Elaboration from OECD National Accounts.

XR, the Exports/GDP ratio, has increased in all countries, but it is not necessarily higher in the most developed countries. As seen in Guisan and Cancelo(2002), development usually implies more trade, well domestic or foreign. In the case of big countries there are many opportunities to increase domestic trade and then it is not necessary the same degree of openness to foreign trade than in small countries.

Table 5 shows that the relation between GDP per capita and Exports per capita is the best of the four options.

Table 5. 25 OECD countries 1962-1995:
Relations between GDP per capita and Exports

PC/PC	Rate/Rate	Rate/share	PC/share
0.6768	0.3647	-0.0323	0.3975

Note: pc means per capita, rate is the exponential rate of growth, share is the Investment/Output Ratio

Tables 6 present the correlations between PH, XH and MH in the sample of 25 OECD countries. In the Annex we include other tables which show lower correlations between rates and ratios of PH with the foreign trade variables.

Table 6. Correlation between per capita variables: PH, XH and MH

	PH90	XH90	MH90
PH90	1.0000	0.6768	0.6500
XH90	0.6768	1.0000	0.9897
MH90	0.6500	0.9897	1.0000

It is important to notice that PH is highly and positively correlated both with XH and MH, because both variables have a positive impact on economic development together with industrial development and other variables, accordingly to the integrated model of development based on three approaches, such as in Guisan(2006), (2007), (2008) and other studies:

1) Demand (Keynesian model)

2) Supply of raw materials and intermediate inputs, including inter-sector relationships and foreign trade. Accordingly to Input-Out relationships from the supply side.

3) Supply of primary inputs (production function)

5. Conclusions

We find that increase of real GDP per capita depends at a great extent, among other factors, on Capital per capita, as to say on the past and current real value of Investment per capita, which very often does not imply increase in the Investment/GDP ratio, well in international comparisons or in time series comparisons of one country, as seen in section 3.

In section 4 we found that the increase of real GDP per capita is usually related with increase in Exports and Imports per capita, due to the important positive impact of industry on development and foreign trade, as well as to the positive impact of foreign trade on industrial and non industrial sectors. It is important to notice that also in the case of foreign trade relationships in per capita terms are usually better than those based in the mix of rates and ratios.

The increase of openness to foreign trade has usually a positive impact on economic development as seen in Guisan(2006) and (2007) and other studies, because the increase of manufacturing production per capita usually increase trade, both domestic and foreign. Small size countries do not have usually a large domestic market and they need very often to increase foreign trade in a greater degree than large countries. The important question is to increase the real amount of exports per capita and imports per capita and not the ratio, because a high rate with a low value has not a relevant impact on economic development.

As seen in the economic literature models relating rates and ratios would lead to confusing, or even wrong conclusions, and thus we recommend to use models in per capita terms in order to compare degrees of economic development, having into account the three approaches mentioned in section 4, or other factors which may be also relevant. Our main conclusion is that several approaches may lead to improve knowledge and policies related with economic development provided that studies are addressed to seek the true accordingly to the always relevant and wise advices of Mayer(1994).

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Annex 1. Data of 25 OECD countries in (PPPs)

Table A1. Data in th dollar per inhabitant at PPPs, 1995

Nb	Country	phpp	ihpp	xhpp	mhpp	chpp
1	Austria	17.748	4.506	7.634	7.706	10.037
2	Australia	17.424	3.680	3.700	3.712	10.609
3	Germany	16.768	3.804	4.578	4.634	9.680
4	Belgium	17.459	3.135	13.581	12.876	11.064
5	Canada	18.690	3.735	6.852	6.246	10.515
6	Denmark	19.004	2.772	7.268	6.663	9.650
7	Spain	12.427	2.743	3.212	3.256	7.651
8	France	17.951	3.375	4.662	4.333	10.649
9	Finland	15.388	2.466	5.357	4.214	7.855
10	Greece	9.486	2.241	1.778	2.859	7.155
11	Netherlands	17.087	3.417	10.375	9.102	10.060
12	Iceland	17.072	2.590	6.025	5.206	10.201
13	Ireland	14.921	2.566	11.636	8.785	7.798
14	Italy	17.187	3.051	4.724	3.853	10.152
15	Japan	18.881	5.558	2.314	2.089	11.212
16	Luxembourg	27.696	6.919	26.012	23.590	14.803
17	Mexico	5.759	0.879	1.817	1.521	3.908
18	Norway	20.421	4.141	9.043	6.784	9.594
19	New Zealand	13.139	2.693	4.212	4.164	8.711
20	Portugal	10.499	2.910	4.021	5.352	6.923
21	Sweden	16.886	2.698	6.833	5.699	8.313
22	Switzerland	20.298	5.377	7.817	7.785	11.963
23	Turkey	5.009	1.188	0.877	1.085	3.349
24	USA	23.125	4.142	2.972	3.388	15.843
25	UK	16.798	2.813	4.792	4.852	10.260

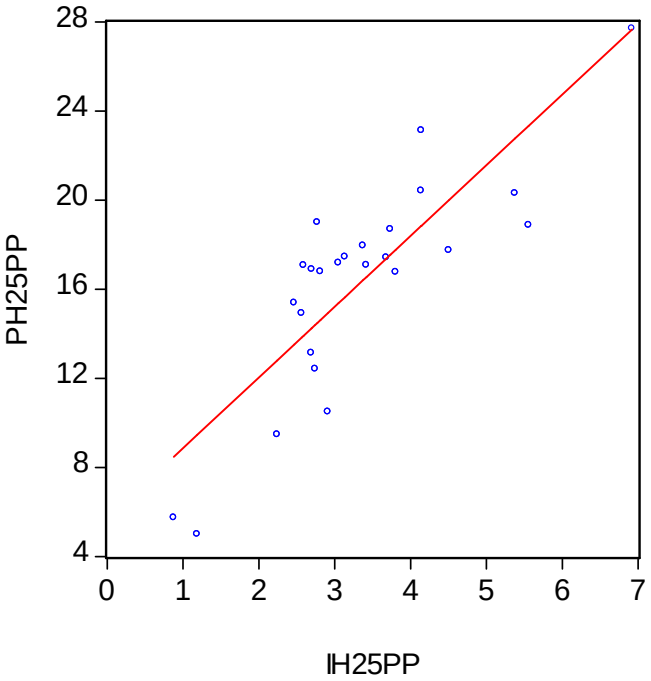
Source: Elaborate by Guisan(2008) from OECD statistics

Table A2. Correlations per capita variables in PPPs

	PH90PP	IH90PP	XH90PP	MH90PP	CH90PP
PH90PP	1.0000	0.8394	0.6284	0.6188	0.9330
IH90PP	0.8394	1.0000	0.5734	0.6017	0.8067
XH90PP	0.6284	0.5734	1.0000	0.9875	0.4836
MH90PP	0.6188	0.6017	0.9875	1.0000	0.5093
CH90PP	0.9330	0.8067	0.4836	0.5093	1.0000

Graph A1 shows the positive relationship between production and investment, in per capita terms, of 25 OECD countries.

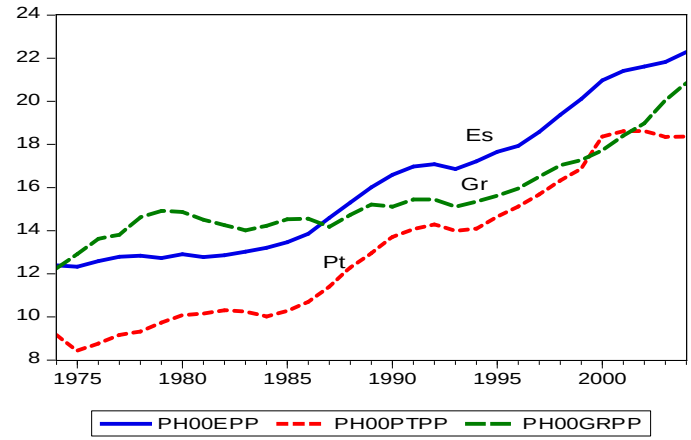
Graph A1. GDP pc and Investment pc in 25 OECD countries
In 1995 (th $ per head at prices and PPPs of year 1990)



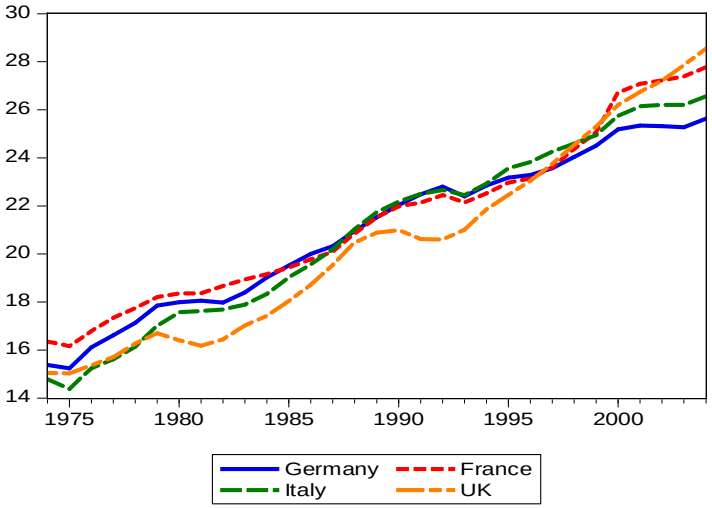
Source: Elaborated from data of table A1.

Graphs A2 and A3 show the evolution of GDP per capita in two groups of European countries, for 1974-2004. The first group corresponds to three countries with middle levels of stock of capital per capita: Spain, Greece and Portugal and the second group to countries with high levels of stock of capital per capita: France, Germany, Italy and the United Kingdom.

Graph A2. Gross Domestic Product per capita: Spain, Portugal, Greece
(thousand dollars at 2000 prices and Purchasing Power Parities)



Graph A3. Gross domestic product per capita: Germany, France, Italy, and the United Kingdom (th $ at 2000 prices and PPPs)



Annex 2. Correlations of rates, ratios and per capita variables in 25 OECD countries for real GDP per capita, foreign trade and investment.

A2.1. Exponential rates of growth: correlation 1962-95

	RPH90	RXH90	RMH90
RPH90	1.0000	0.3647	0.6023
RXH90	0.3647	1.0000	0.2066
RMH90	0.6023	0.2066	1.0000

A2.2. Per capita real values 1962-95. correlation 1962-95

	PH90	XH90	MH90
PH90	1.0000	0.6768	0.6500
XH90	0.6768	1.0000	0.9897
MH90	0.6500	0.9897	1.0000

A2.3.Rate of growth and ratios (shares): correlation 1962-95

	RPH90	SX90	SM90
RPH90	1.0000	-0.0323	-0.0058
SX90	-0.0323	1.0000	0.9722
SM90	-0.0058	0.9722	1.0000

A2.4.GDP per capita and ratios (shares): correlation 1962-95

	PH90	SI90	SX90	SM90
PH90	1.0000	-0.0869	0.3975	0.2976
SI90	-0.0869	1.0000	-0.0191	0.0835
SX90	0.3975	-0.0191	1.0000	0.9722
SM90	0.2976	0.0835	0.9722	1.0000

We may notice that the better results, showing the positive correlation of economic development with Exports and Imports correspond to table A2.2., as to say to the comparison in per capita terms among GDP per capita (PH), Exports per capita (XH) and Imports per capita (MH). The positive impact of Imports and Exports, given a sustainable foreign trade balance, is explained in other studies like in Guisan(2006) and (2007).

Annex 3. Estimation of a linear production function with two options

The following tables present the estimation of a linear production function in 7 OECD countries for the period 1964-1990 with increase of K90 in equation 1, and with I90 given by the increase of Gross Fixed Capital Formation per inhabitant in equation 2.

Equation 1.
Dependent Variable: PIB90?
Method: Pooled Least Squares. Sample(adjusted): 1964 1990
Included observations: 27 after adjusting endpoints
Number of cross-sections used: 7. Total panel (balanced) obs: 189
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PIB90?(-1)	0.995360	0.005291	188.1284	0.0000
D(K90?(-1))	0.487140	0.099276	4.906905	0.0000
D(LT?)	0.046283	0.005157	8.974726	0.0000

R-squared	0.999510	Mean dependent var	1371.065
Adjusted R-squared	0.999505	S.D. dependent var	1236.323
S.E. of regression	27.51414	Sum squared resid	140807.2
Log likelihood	-893.1457	F-statistic	189699.7
Durbin-Watson stat	1.171737	Prob(F-statistic)	0.000000

Equation 2.
Dependent Variable: PIB90?
Method: Pooled Least Squares. Sample: 1963 1990
Included observations: 28
Number of cross-sections used: 7. Total panel (balanced) obs: 196
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PIB90?(-1)	1.013468	0.003432	295.3350	0.0000
D(I90?(-1))	0.292259	0.159496	1.832391	0.0684
D(LT?)	0.039474	0.006368	6.199189	0.0000

R-squared	0.999439	Mean dependent var	1349.636
Adjusted R-squared	0.999433	S.D. dependent var	1226.714
S.E. of regression	29.20330	Sum squared resid	164596.8
Log likelihood	-937.9596	F-statistic	171942.5
Durbin-Watson stat	1.309644	Prob(F-statistic)	0.000000

The results show that the lagged value of Gross Fixed Capital formation may be a good proxy for the increase of real stock of capital available at the beginning of the year, although it is usually better to get availability of capital data for the analysis of production functions.